VII.2 Hydrogen Codes and Standards

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Start Date:  1995
Projected End Date:  Project continuation and
direction determined annually by DOE

Objectives

- Facilitate creation and adoption of model building codes and equipment standards for hydrogen systems in commercial, residential, and transportation applications.
- Coordinate and conduct research and development (R&D) needed to establish sound technical requirements for standards, codes, and regulations for hydrogen components and systems.
- Provide technical resources to harmonize development of international standards among the International Organization for Standardization (ISO), International Electrotechnical Commission (IEC), and Working Party on Pollution and Energy (GRPE).

Technical Barriers

This project addresses the following key technical barriers from the Codes and Standards section (3.6.4.2) of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

(A) Limited Government Influence on Model Codes
(B) Competition among Standard Development Organizations (SDO) and Model Code Development Organizations (CDO)
(D) Large Number of Local Government Jurisdictions (approximately 44,000)
(F) Limited DOE Role in the Development of International Standards
(G) Inadequate Representation at International Forums
(I) Conflicts between Domestic and International Standards
(J) Lack of National Consensus on Codes and Standards
(K) Lack of Sustained Domestic Industry Support at International Technical Committees
(M) Jurisdictional Legacy Issues
(P) Large Footprint Requirements for Hydrogen Fueling Stations

Technical Approach

- Support and facilitate the timely and efficient incorporation of hydrogen safety issues into existing and proposed codes and/or standards promulgated by organizations such as the ICC, NFPA, Society of Automotive Engineers (SAE), and ISO.
- Support and encourage technical and operational consistency among and across the codes and standards developed by different organizations.
- Identify critical gaps and deficiencies in codes and standards and formulate recommendations to address them.
- Develop a unified national agenda and help support consistent representation of technical experts from industry and government at key global venues.
- Work with key agencies and industry in other countries to harmonize standards, codes, and regulations in all major market areas for hydrogen technologies.
- Develop collaborative, international R&D and testing plan to obtain data needed to advance preliminary technical specification for fuel quality to an international standard.
• Initiate R&D for an integrated engineering systems approach to hydrogen safety.
• Initiate R&D for component testing, focusing on gaseous hydrogen containers and hydrogen fueling stations.

Accomplishments

• National templates for standards, codes, and regulations for hydrogen vehicles and facilities, and for on-site hydrogen generation and stationary and portable fuel cells accepted by major SDOs in the U.S., FreedomCAR and Fuel Partnership (FCFP), key industry associations, and many state and local governments as guideposts for coordinated development of standards and model codes.
• National templates incorporated in Codes and Standards RD&D Roadmap of FCFP.
• NREL continued to support development of key standards to implement national templates:
  - American National Standards Institute (ANSI): ANSI modified its National Resource for Global Standards to include the Hydrogen and Fuel Cells Codes and Standards Portal (http://hcsp.ansi.org): a web-based database and search engine for hydrogen and fuel-cell-related codes and standards of participating CDOs and SDOs (e.g., NFPA, ICC, ASME). The Hydrogen and Fuel Cell Codes and Standards Matrix and Database, which catalogs and tracks national and international codes and standards in the development process, was integrated into the Hydrogen Portal and linked to the Hydrogen and Fuel Cell Safety Report.
  - American Society of Mechanical Engineers (ASME): ASME prepared a technical report, Hydrogen Standardization Interim Report for Tanks, Piping, and Pipelines. The report provides a technical basis for a standard for high-pressure hydrogen stationary, transportable, and portable tanks and for a standard addressing the use of non-steel metals and composite materials for high-pressure hydrogen storage tanks. ASME prepared a second technical report, Design Margin Guidelines for High-Pressure Composite Hydrogen Tanks to address safety factors in composite storage tanks. ASME also initiated development of ASME B31.12, which will provide recommendations for design criteria and materials for high-pressure piping in hydrogen service.
  - Compressed Gas Association (CGA): CGA, administrator for the U.S. Technical Advisory Group (TAG) of ISO TC197, refined a web site to manage TAG activity, including accessing drafts of documents, accessing comments, and voting.
  - CSA America: CSA America is developing standards for hydrogen fueling systems. CSA America is also developing a process through which requirements included in initial drafts of these standards can be made more performance-based and, where appropriate, harmonized with the requirements of the Federal Motor Vehicle Safety Standards.
  - International Code Council (ICC): The ICC Ad Hoc Committee for Hydrogen Gas (AHCHG) completed development of new hydrogen safety requirements (and modifications to existing requirements) for incorporation in the 2006 editions of the International Building Code, International Fire Code, and International Fuel Gas Code. With the 2005 Code Development Hearings, the AHCHG completed its work and was disbanded by the ICC.

• The ICC, NFPA, and National Hydrogen Association (NHA) formed a Hydrogen Industry Panel on Codes (HIPOC) to provide a neutral forum to develop and submit hydrogen-related code provisions to both the ICC and the NFPA. The HIPOC will play a key role in harmonizing provisions in ICC and NFPA codes and standards. The HIPOC formulated new hydrogen-related safety requirements for consideration at the 2006 ICC Code Development Hearings.
• Continued (with U.S. Fuel Cell Council and NHA) to support a single national committee, the National
Hydrogen and Fuel Cells Codes and Standards Coordinating Committee (NHFC4), to consolidate hydrogen and fuel cell codes and standards coordination.

- NREL reached agreement with NHA to expand the scope of the Hydrogen Safety Report to serve as the principal vehicle of communication for the NHFC4.
- Continued to explore collaborative R&D among the United States, Japan, and the European Union on hydrogen safety, codes, and standards.
- Led U.S. and Canadian team of experts from industry, government, and academia to establish an agreement with Japan and the European Union on the development of hydrogen fuel quality specifications for PEM fuel cell road vehicles under ISO.
- Coordinated DOE efforts to establish a unified international R&D program to obtain data needed to create an international standard based on modifications to the ISO technical specification for hydrogen fuel quality, including baseline fuel quality testing at the University of Hawaii with single-cell test hardware and expertise from General Motors, UTC Fuel Cells, and Ballard Power Systems.
- Worked with the Codes and Standards Tech Team of the FCFP to revise its R&D Roadmap and to coordinate efforts on R&D for fuel quality, integrated safety engineering, risk assessment, and detection and mitigation of hydrogen hazards.
- Participated in the peer review of the Codes and Standards Tech Team by the National Academy of Sciences (NAS).
- Conducted and hosted (with Sandia National Laboratories) a second workshop to address risk assessment activities, methodologies, and data requirements in conjunction with IEA Annex 19, Hydrogen Safety.

**Introduction**

The development and promulgation of codes and standards are essential for establishing a market-receptive environment for hydrogen-based products and systems and, in turn, for hydrogen to become a significant energy carrier and fuel. With the help of key stakeholders, the DOE Hydrogen, Fuel Cells, and Infrastructure Technologies (HFCIT) Program and NREL are coordinating a collaborative national effort to prepare, review, and promulgate hydrogen codes and standards needed to expedite hydrogen infrastructure development.

The DOE Hydrogen Codes and Standards Program facilitates the creation and adoption of model building codes and equipment standards for hydrogen systems in commercial, residential, and transportation applications and provides technical resources to harmonize the development of international standards. NREL continues to coordinate and provide overall management of domestic codes and standards activities on behalf of DOE and the FCFP Codes and Standards Tech Team. NREL also helps DOE and the Tech Team create a unified agenda for hydrogen standards, codes, and regulations that will enable the United States to present an industry and government consensus position at critical international negotiations on global hydrogen standards and regulations.

**Approach**

The federal government has an indirect and relatively limited role in the voluntary consensus process through which codes and standards are developed in the United States (Barrier A). Because of the importance of establishing a harmonized set of standards on which model codes and regulations can be based, DOE, primarily through NREL, has devoted considerable effort to facilitating and coordinating this consensus process.

NREL helps DOE and the FCFP Codes and Standards Tech Team implement the R&D Roadmap by coordinating and conducting R&D needed to establish sound technical requirements for standards, codes, and regulations for hydrogen components and systems. Key R&D areas supported by NREL include integrated engineering approaches to hydrogen safety and comprehensive R&D and testing to develop data for international hydrogen fuel quality standards.

**Results**

Key results in domestic codes and standards are summarized in Table 1.
### TABLE 1. Key Results in Domestic Codes and Standards

<table>
<thead>
<tr>
<th>Standard, Model Code</th>
<th>Organization</th>
<th>Status</th>
<th>Finish Date</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Infrastructure</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gaseous storage, transport and portable tanks</td>
<td>ASME</td>
<td>Interim report: Pt. 1 - Review of existing reference standards</td>
<td>May 05</td>
<td>Appropriate design requirements, up to 15,000 psi</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Interim report: Pt. 2 - Study of existing data, standards, and materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piping and pipelines</td>
<td>ASME</td>
<td>Interim report: Pt. 3 - Study of existing data, standards, and materials</td>
<td>May 05</td>
<td>Design margins in ASME B31, 49CFR 192 to 15,000 psi</td>
</tr>
<tr>
<td>Dispensing systems</td>
<td>CSA (HGV 4.1)</td>
<td>Draft standard completed</td>
<td>In review</td>
<td></td>
</tr>
<tr>
<td>Hoses</td>
<td>CSA (HGV 4.2)</td>
<td>Draft standard completed</td>
<td>In review</td>
<td></td>
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<tr>
<td>Temp. compensation devises</td>
<td>CSA (HGV 4.3)</td>
<td>Draft standard completed</td>
<td>In review</td>
<td></td>
</tr>
<tr>
<td>Breakaway devices</td>
<td>CSA (HGV 4.4)</td>
<td>Draft standard completed</td>
<td>In review</td>
<td></td>
</tr>
<tr>
<td>Priority/sequencing</td>
<td>CSA (HGV 4.5)</td>
<td>Draft standard completed</td>
<td>In review</td>
<td></td>
</tr>
<tr>
<td>Manually operated valves</td>
<td>CSA (HGV 4.6)</td>
<td>Draft standard completed</td>
<td>In review</td>
<td></td>
</tr>
<tr>
<td>Automatic high pressure valves</td>
<td>CSA (HGV 4.7)</td>
<td>Draft standard completed</td>
<td>In review</td>
<td></td>
</tr>
<tr>
<td><strong>H2 Fueled Vehicles</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure relief devices</td>
<td>CSA</td>
<td>Draft standard completed (PRD1/HPRD1)</td>
<td>In review</td>
<td>Combined with PRD1</td>
</tr>
<tr>
<td><strong>Interface</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel specification for PEMFC vehicles</td>
<td>ISO TC197</td>
<td>Draft Technical Specification (TS14687-2) in review</td>
<td>Jun 06</td>
<td>Harmonized with SAE J2719</td>
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<tr>
<td>Fuel specification for stationary systems</td>
<td>CGA</td>
<td>Revision of existing standard</td>
<td>TBD</td>
<td>Work deferred pending ISO, SAE guidelines</td>
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<tr>
<td>Weights and measures</td>
<td>NIST</td>
<td>Draft standard for hydrogen gas metering</td>
<td>In review</td>
<td>NIST handbooks 44 and 112</td>
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<tr>
<td>Gas and vapor detector/sensor</td>
<td>UL</td>
<td>Standard (UL 2075) published</td>
<td>Nov 04</td>
<td>Toxic/flammable gas detection</td>
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<tr>
<td><strong>Built Environment</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fueling station</td>
<td>ICC</td>
<td>Provisions for underground LH₂ storage, gaseous canopy storage adopted</td>
<td>June 05</td>
<td>2006 editions fire, fuel gas codes</td>
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<tr>
<td>Hydrogen production rooms</td>
<td>ICC</td>
<td>Adopted in 2003 edition</td>
<td>Oct 05</td>
<td>Residential, mechanical codes</td>
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<tr>
<td>Vehicular fuel systems</td>
<td>NFPA 52</td>
<td>2005 edition published</td>
<td>Aug 05</td>
<td>CNG/LNG, GH/LH</td>
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<td>Gaseous, liquid fuel storage/handling</td>
<td>NFPA 55</td>
<td>2005 edition published</td>
<td>Aug 05</td>
<td>Combines 50A/50B</td>
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<td>Building construction safety code</td>
<td>NFPA 5000</td>
<td>New edition</td>
<td>2006</td>
<td>Refers to NFPA 52/55</td>
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<td><strong>Stationary, Portable Fuel Cells</strong></td>
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<tr>
<td>Fuel cells for telecommunications</td>
<td>UL</td>
<td>Draft standard (UL 2266) in review</td>
<td>TBD</td>
<td>EM compatibility, electrical safety</td>
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<td>Hand-transportable fuel cells</td>
<td>UL</td>
<td>Draft standard (2265) in development</td>
<td>TBD</td>
<td>Disposable methanol cartridges</td>
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<tr>
<td>Gaseous hydrogen generators</td>
<td>UL</td>
<td>UL2264B (electrolyzers) in review, UL2264A (water reaction) and UL2264C (reformers) in development</td>
<td>TBD</td>
<td>Involves CSA, ISO</td>
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<tr>
<td>Fuel cells for industrial trucks</td>
<td>UL</td>
<td>Draft standard (UL2267) in development</td>
<td>TBD</td>
<td>Forklifts, tugs</td>
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<tr>
<td><strong>Other</strong></td>
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<tr>
<td>Hydrogen Portal</td>
<td>ANSI</td>
<td>1st rollout 7-20-04</td>
<td>1st version, 6-15-05</td>
<td>Electronic access to standards</td>
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<td>ISO TC197 USTAG website</td>
<td>CGA</td>
<td>Operational</td>
<td>Aug 05</td>
<td>Post information, voting</td>
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</table>
Conclusions and Future Directions

NREL will continue to support the development and promulgation of hydrogen codes and standards by:

- Implementing the national templates for hydrogen codes and standards.
- Building the NHFC4 to consolidate domestic and international codes and standards activities.
- Coordinating and conducting R&D based on the Codes and Standards Tech Team Roadmap.
- Initiating R&D collaboration with Asia and Europe on hydrogen safety, codes, and standards, beginning with hydrogen fuel quality.
- Coordinating the participation and input of U.S. and Canadian industry in developing a technical specification for hydrogen fuel quality under ISO.

FY 2006 Publications/Presentations

2. Presentation on codes and standards at HFCIT Merit Review.
4. Presentation on fuel quality R&D/testing plan to ISO TC197 WG12.
5. Presentation on national templates to National Hydrogen and Fuel Cells Codes and Standards Coordinating Committee.
6. Presentations on DOE/NREL hydrogen codes and standards activities to Savannah River National Laboratory and Johnson Matthey.